

Attack on Titan: a record of predation on the Chinese reddish mantis *Hierodula chinensis* (Mantodea, Mantidae) by the orb-web weaving spider *Gibbaranea abscissa* (Araneae, Araneidae)

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Abstract

Prey–predator interaction is a phenomenon important to our understanding of community dynamics. Mantises and web-weaving spiders are predators that belong to the same guild, and they can be each other's predator and prey. However, their relationship is generally asymmetrical, with spiders often being the prey of the mantises. Here, we report a rare opposite case in which an adult female mantis, *Hierodula chinensis* Werner, 1929, was preyed upon by the orb-web weaving spider *Gibbaranea abscissa* (Karsch, 1879), without using a web, in a late autumn field in Japan. We suggest that differences in cold tolerance allowed the small spider to hunt a mantis prey that was approximately eight times its size.

Keywords

alien species, intraguild predation, low-temperature tolerance, prey–predator interaction

Introduction

Intraguild predation, namely predatory interactions among members of the same guild, is an important factor in determining community structure by diminishing top-down impacts on lower trophic levels (Polis and Holt 1992). Intraguild predation has received much attention, not only in furthering our understanding of community dynamics but also in applied ecological studies, such as predicting the effects of exotic predators on native communities (Gerber and Echternacht 2000, Müller and Brodeur 2002, Gardiner et al. 2011) or the top-down impacts of predator diversity on pest populations (Hodge 1999). The relationship between predators within guilds is often asymmetrical, with one behaving as an intraguild predator and the other as an intraguild prey. Differences in body size play an important role in determining this prey–predator relationship. For example, the larger animal behaves as a predator, with the smaller one as prey (Woodward and Hildrew 2002). In addition, the prey–predator relationship

among predator species can be weakened or reversed by the size inversions associated with different developmental stages (e.g., Snyder and Hurd 1995). However, in rare cases, a smaller predator may eat a larger predator (Ohba 2012, Nyffeler et al. 2017).

Mantises and web-weaving spiders are important predators in natural ecosystems, and intraguild predation occurs between them (Hurd et al. 2015). Mantises basically behave as intraguild predators of spiders, and predation of mantises by web-weaving spiders is rarely seen. One reason is that mantises are larger than spiders, and another is that mantises can cut the capture threads of spiders with their mouthparts and escape when captured in a spider web (Sugiura et al. 2019, 2020). Some species of web-weaving spiders show defensive behavior specifically to avoid mantis predation, suggesting that mantises are important agents of selection pressure (Bruce et al. 2001, Herberstein and Heiling 2001).

Here, we report a rare case of an orb-web weaving spider, *Gibbaranea abscissa* (Karsch, 1879) (Araneae, Araneidae), preying on a substantially larger mantis, *Hierodula chinensis* Werner, 1929 (Mantodea, Mantidae).

Materials and methods

A survey was conducted on the morning of November 28, 2015 in a mixed forest field (35°20'39.9"N, 139°12'15.5"E) in Ashigarakami-gun, Kanagawa Prefecture, Honshu Island, Japan, by one of the authors (KY) with the aim of monitoring the population of *H. chinensis* by sight. KY searched with the naked eye for praying mantises and collected them by hand.

Results and discussion

One adult female mantis perched on a tree branch about 2 m above the ground was collected. The individual was already dead at the time of collection but still perched on the branch. It was identified as *H. chinensis* by the taxonomic characters of Yamasaki

et al. (2022). When checked after collection, we found a juvenile female *G. abscissa* (body size 8.5 mm) on the head of the mantis, indicating that the spider was feeding on the mantis (Fig. 1A). Although spider silk was wrapped around the head and forelegs of the mantis (Fig. 1B), there was no spider web around the other parts of the mantis, suggesting that *G. abscissa* had fed on the mantis by wrapping it directly with a capture silk without using a web.

Although photos of web-weaving spiders eating mantises can be seen on the Internet, to the best of our knowledge, this is the first report of a web-building spider observed in the field feeding on an adult mantis without using a silk web. Although *G. abscissa* is an orb-web weaving spider, it sometimes wanders and preys on insects without using a web (Shinkai 1989). The prey–predator size ratio is noteworthy. The insect that Shinkai (1989) described as the prey of *G. abscissa* was an unidentified weevil of unknown size. *Gibbaranea abscissa* is considered a generalist predator based on its orb-web weaving habit, but there are few records other than Shinkai (1989) on the predatory behavior and prey taxonomic range of this species. In contrast, the prey we observed was an adult female *Hierodula chinensis* with a total length of more than 70 mm—a huge prey for the juvenile *G. abscissa* (length ratio of about 8 to 1). On this occasion, we did not observe the spider capturing the praying mantis. However, as the mantis head and forelegs were entangled with the capture threads (Fig. 1B), it is unlikely that the spider fed on the dead mantis, supporting the possibility that it preyed on the mantis after blocking its movement with capture threads.

We suggest that the factor that enabled *G. abscissa* to hunt *H. chinensis* may have been the low temperature in the field. The temperature was 6 °C at 9:30 a.m. when we collected the mantis

that was being eaten by the spider, and the other live mantises that we collected at about that time were almost immobile from cold paralysis. In temperate regions, Japanese Mantodea species (except one species) overwinter in their oothecae (Nakamine et al. 2017). November is nearly the end of the life history of *H. chinensis* in the study field. Some adult individuals reach the end of their lifespan and die. Even those who are healthy enough to survive until the following December are active during the day but are unable to move at night or in the morning due to the low temperatures (Fig. 2). In contrast, the juvenile *G. abscissa* that preyed on the mantis was active enough to move around immediately after we collected it. Unfortunately, the physiological tolerance of *G. abscissa* to low temperatures has not been investigated. However, several ecological characteristics suggest that this species is tolerant to low temperatures. One is phenology. Many Japanese araneid species are active during the warm season and mature in summer, but this species is one of the few that mature during the cold season (autumn to spring) (Shinkai 2017). The other is distribution. Apart from Japan, *G. abscissa* is also distributed in Far Eastern Russia, where winter temperatures are below freezing (Marusik et al. 2015). On the other hand, the northern limit of distribution for *H. chinensis* is Beijing, China, where it is distributed in warmer regions (Liu et al. 2020, Wang et al. 2020). These ecological aspects are consistent with the fact that *G. abscissa* was actively foraging in autumn. These suggest that intraguild prey–predator relationships can be reversed depending on the ambient temperature and the temperature-dependent activity of each organism; differences in low-temperature tolerance may enable the spiders to hunt huge mantis prey without using webs.

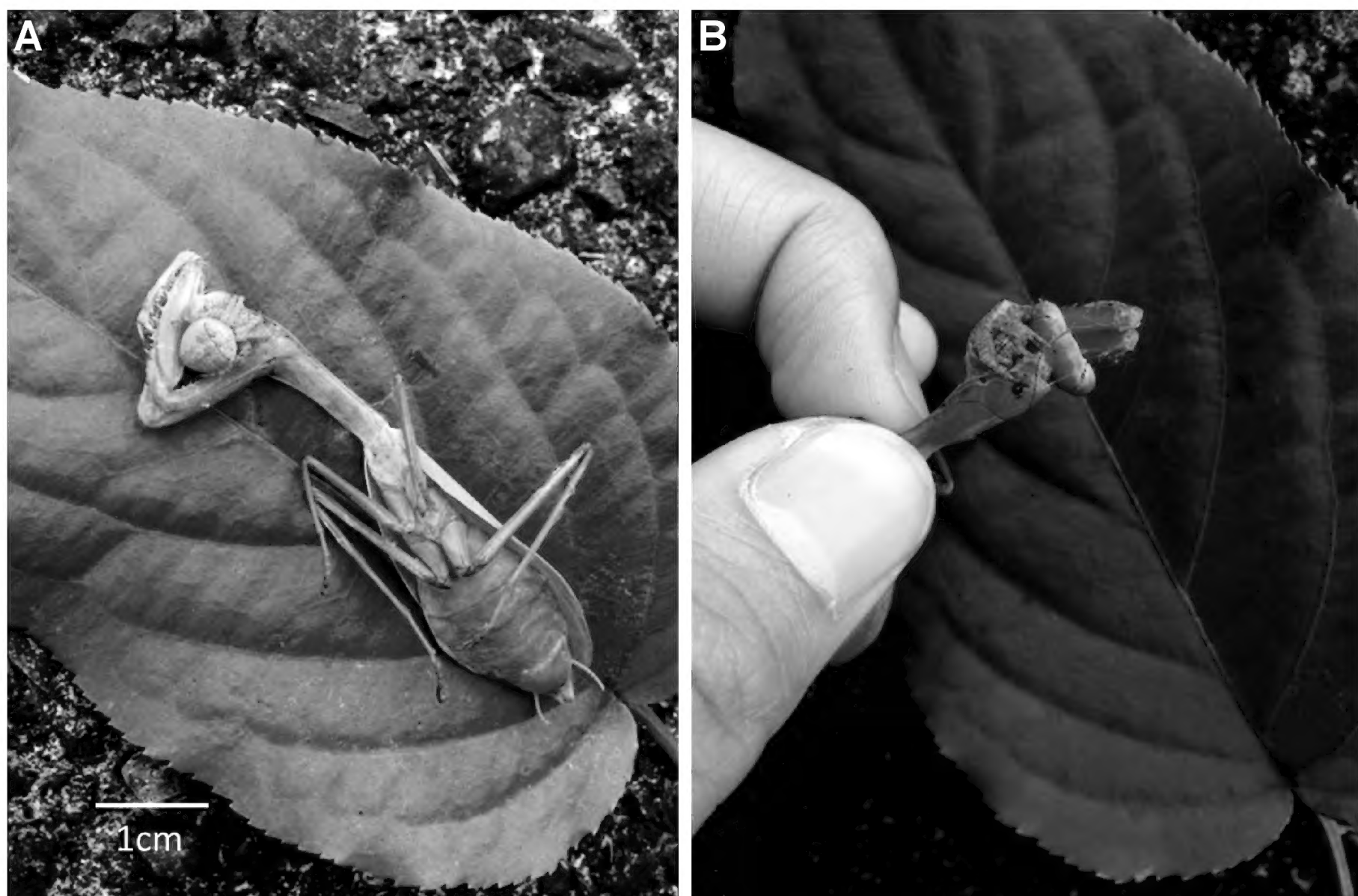


Fig. 1. Juvenile *Gibbaranea abscissa* and its prey *Hierodula chinensis*. A. Enlarged view; B. Note the spider silk wrapped about the head and forelegs of the mantis. Scale bar: 1 cm (A).

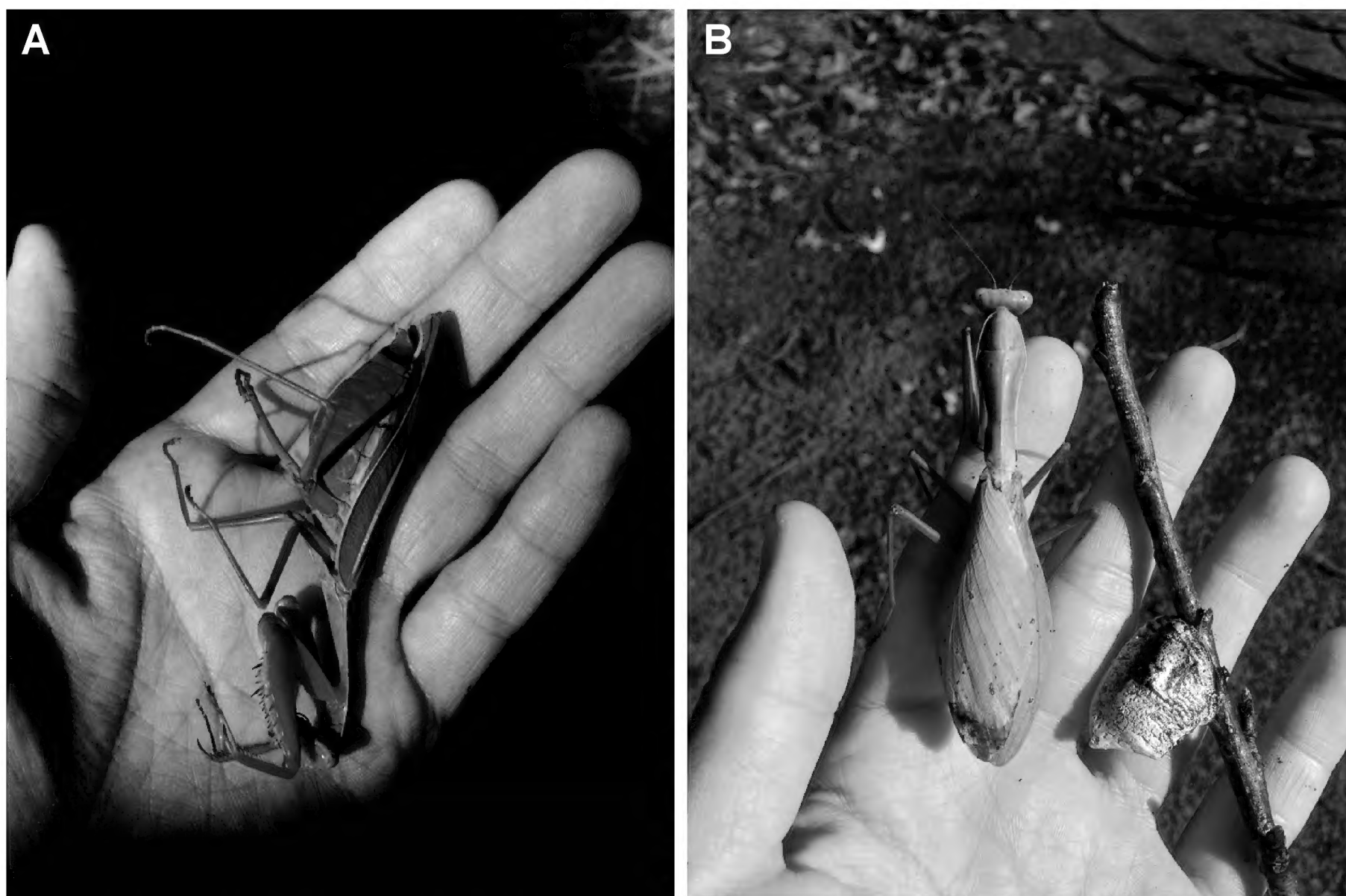


Fig. 2. *Hierodula chinensis* alive in November. **A.** Under cold paralysis from night to morning (taken on November 7, 2016); **B.** Active in daytime (taken on November 28, 2015, the same day of this study). Note that the two individuals in the pictures are not the same.

Our finding is also novel in that it shows that the web-weaving spider *G. abscissa* can be a natural enemy of *H. chinensis*. *Hierodula chinensis* is suspected of being an alien species because its distribution has only recently been confirmed in Japan (e.g., Yoshitsuru 2013, Ichikawa 2014), although as yet, there is no direct evidence to support this possibility. The basic ecology of this potentially invasive species, including its effects on native species assemblages and the natural enemies of such species, is still largely unknown. It is also not clear whether this unique phenomenon can be seen as one of the usual intraguild predations between *G. abscissa* and *H. chinensis* or whether it is a rare exception. To understand this ecology, we will need to clarify interspecific interactions involving this mantis, such as prey–predator interactions, in a future study.

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